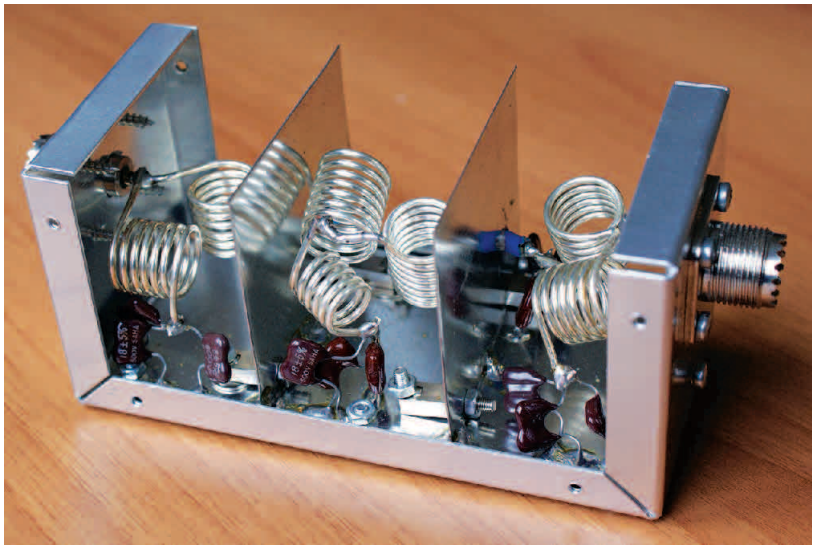

[Angelo Protopapa, IKØVVG, photo]

A Low-Pass Filter for HF Operations

This filter gives extra signal rejection above 30 MHz.

Angelo Protopapa, IKØVVG

Low-pass filters (LPFs) for HF have been widely used in the past to prevent television interference and help with RFI problems. I recommend using an LPF when operating in an apartment environment, or when very close to other houses, to eliminate unexpected interference from the HF radio. A version of this article was published in Italian in *Radio Rivista* magazine.[1]

Filter Design

I placed two identical classical T cells (see Figure 1), each characterized by an 18 dB/octave slope in the transition zone, to get a frequency response slope in the transition zone of 36 dB/octave (see Figure 2). The simulated transmission frequency response, S12, and the input return loss, S11, are shown in Figure 2.

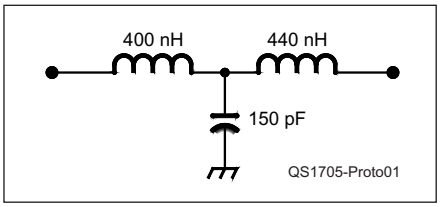

Figure 1 — Classical T cell low-pass filter.

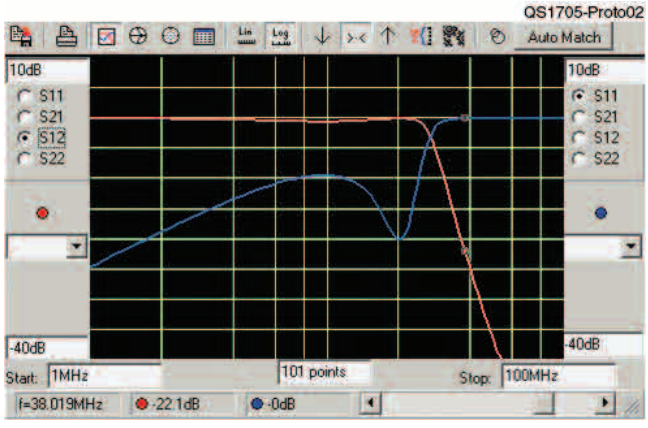

Figure 2 — Frequency response and return loss of two identical T cells in tandem.

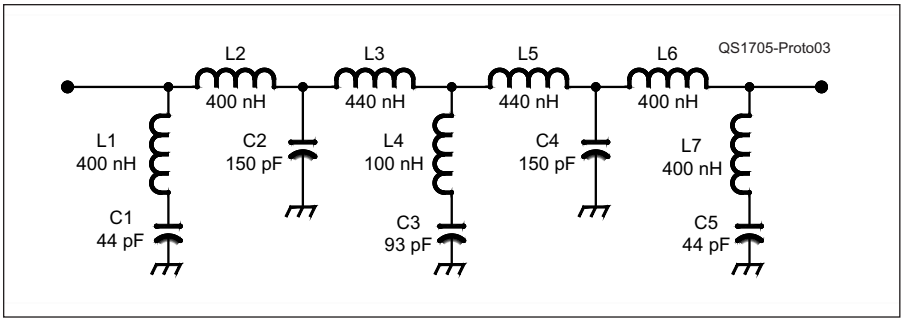

Figure 3 — Final schematic configuration for the low-pass filter.

C1, C5 — Silver mica capacitor, 44 pF (see text)
C2, C4 — Silver mica capacitor, 150 pF (see text)
C3 — Silver mica capacitor, 93 pF (see text)
L1, L2, L6, L7 — Inductor, 400 nH: six turns, 15 millimeters long, wound on a 13-millimeter coil form diameter
L3, L5 — Inductor, 440 nH: seven turns, 20 millimeters long, wound on a 13-millimeter coil form diameter
L4 — Inductor, 100 nH: five turns, 13 millimeters long, wound on an 8-millimeter coil form diameter

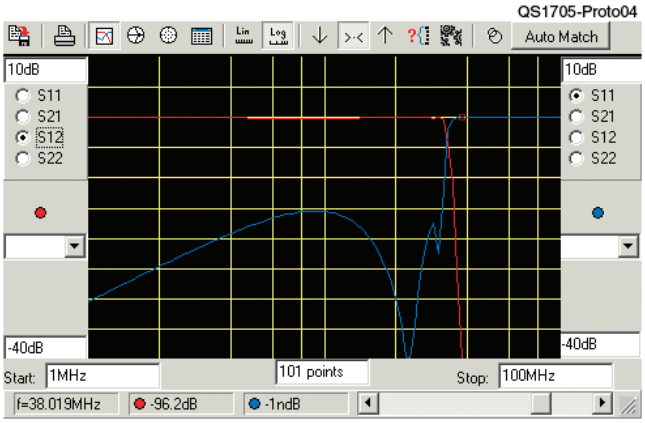

Figure 4 — Simulated frequency response of the return loss (blue) and transmission (red) of the low-pass filter.

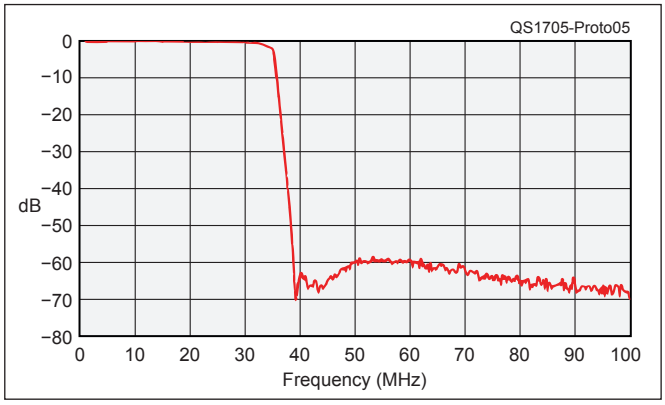

Figure 5 — Measured low-pass filter transmission response.

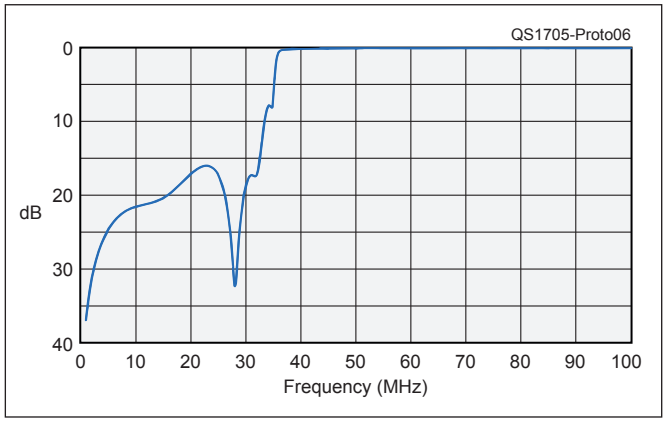

Figure 6 — Measured low-pass filter return loss.

To further improve the slope in the transition zone while maximizing the return loss (minimizing voltage standing-wave ratio — VSWR) on both input and output ports, I added LC series circuits across the input, and across the output. These introduce a null at 37.9 MHz. I also added an LC series circuit across the junction of the two T cells, which introduces a null at 52.2 MHz. The final configuration for the LPF is shown in Figure 3, and its frequency response and return loss are presented in Figure 4. The simulations were made using the *RFSim99* software tool.[2]

Filter Construction

My filter is housed inside a 5 × 2.4 × 2.4 inch aluminum box (see the lead photo) with a tinned steel sheet placed inside on the bottom. The same material is used to create a shield between the LPF stages. The inductances were realized using 1.5-millimeter diameter [approximately #15 AWG — *Ed.*] silver-plated copper wire.

The 440 nH inductors are seven turns, 20 millimeters long, wound with 16-millimeter external diameter (13-millimeter coil form diameter).

The 400 nH inductors are six turns, 15 millimeters long, wound with 16-millimeter external diameter (13-millimeter coil form diameter).

The 100 nH inductor is five turns, 13 millimeters long, wound with 11-millimeter external diameter (8-millimeter coil form diameter).

The capacitances are parallel combinations of 500 V dc silver mica capacitors. The 150 pF capacitors are 47 pF, 47 pF, and 56 pF in parallel. The 44 pF capacitors are 18 pF, 18 pF, and 8 pF in parallel. The 93 pF capacitor is 30 pF, 30 pF, and 33 pF in parallel.

Measured Results

I tested the LPF response with an Agilent HP-8753D network analyzer, with the results shown in Figure 5 for the transfer response, and Figure 6 for the return loss in decibels. The measured insertion loss was less than 0.3 dB over the entire HF passband. I have used the LPF with up to 700 W PEP without any problem. For higher power levels, different types of capacitors should be used.

Notes

[1]A. Protopapa, IKØVVG, "Filtro Passa-basso anti TVI per HF," Associazione Radioamatori Italiani, *Radio Rivista*, Jul./Aug. 2007, pp. 84 – 85.

[2]*RFSim99* is available from **www.electroschematics.com/835/rfsim99-download/**.

Angelo Protopapa, IKØVVG, was first licensed in 1993 and mainly operates from Rome and, during summer holidays, from Porto Cesareo as IKØVVG/7. He is an ARRL member and earned Amateur Extra class license ADØGM in 2013. Angelo received a degree in electronic engineering in 1985, and works in the defense electronics sector on air traffic control systems. He is active on the HF bands, and on SSB, CW, and RTTY. He enjoys homebrewing and constructing transceivers, linear amplifiers, and antennas. You can reach Angelo at **protopapa.angelo@gmail.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

VOTE
Did you enjoy this article? Cast your vote at
www.arrl.org/cover-plaque-poll